



US008940429B2

(12) **United States Patent**
Spare

(10) **Patent No.:** **US 8,940,429 B2**
(45) **Date of Patent:** **Jan. 27, 2015**

(54) **CONSTRUCTION OF NON-RECTANGULAR BATTERIES**

(75) Inventor: **Bradley L. Spare**, Oceanside, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 265 days.

(21) Appl. No.: **12/837,932**

(22) Filed: **Jul. 16, 2010**

(65) **Prior Publication Data**

US 2012/0015236 A1 Jan. 19, 2012

(51) **Int. Cl.**

H01M 2/02 (2006.01)

H01M 6/46 (2006.01)

H01M 10/0585 (2010.01)

H01M 10/0525 (2010.01)

H01M 2/26 (2006.01)

H01M 10/04 (2006.01)

H01M 10/0565 (2010.01)

(52) **U.S. Cl.**

CPC **H01M 10/0525** (2013.01); **H01M 2/0275** (2013.01); **H01M 2/266** (2013.01); **H01M 10/0436** (2013.01); **H01M 10/049** (2013.01); **H01M 10/0565** (2013.01); **H01M 10/0585** (2013.01); **H01M 2002/0205** (2013.01); **Y02E 60/122** (2013.01)

USPC **429/153**; 429/156; 429/159; 429/162; 429/178

(58) **Field of Classification Search**

USPC 429/162, 153, 156, 159, 178
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,910,382 A	6/1999	Goodenough et al.	
5,916,707 A	6/1999	Omaru et al.	
6,224,995 B1	5/2001	Fauteux et al.	
6,991,873 B2	1/2006	Sakai et al.	
2002/0150816 A1 *	10/2002	Sakai et al.	429/94
2009/0159582 A1	6/2009	Chami	
2011/0183183 A1 *	7/2011	Grady et al.	429/152

FOREIGN PATENT DOCUMENTS

CN	1508899	6/2004
CN	101411005	4/2009
CN	101523656	9/2009
EP	1102336	5/2001
EP	1195838 A2	4/2002
JP	6333543 A	12/1994
JP	2001028275	1/2001
JP	2008066089 A	3/2008

(Continued)

OTHER PUBLICATIONS

Ahn et al., Machine translation of KR 2007-096280 A, Oct. 2007.*

(Continued)

Primary Examiner — Sean P Cullen

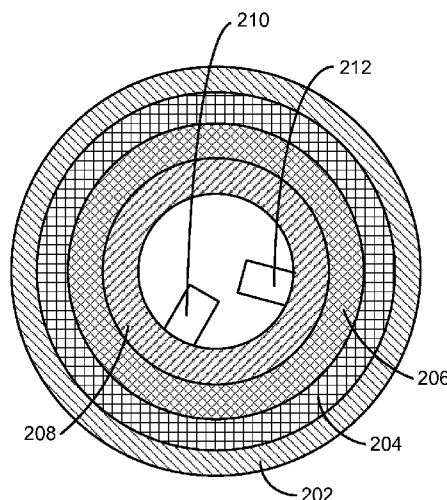
(74) *Attorney, Agent, or Firm* — Brownstein Hyatt Farber Schreck, LLP

(57)

ABSTRACT

The disclosed embodiments relate to a battery cell which includes a set of electrode sheets of different dimensions arranged in a stacked configuration to facilitate efficient use of space inside a portable electronic device. For example, the electrode sheets may be arranged in the stacked configuration to accommodate a shape of the portable electronic device. The stacked configuration may be based on a non-rectangular battery design such as a toroidal design, an L-shaped design, a triangular design, a pie-shaped design, a cone-shaped design, and/or a pyramidal design.

20 Claims, 6 Drawing Sheets



(56)

References Cited

FOREIGN PATENT DOCUMENTS

KR	100883922	10/2007
KR	1020070096280	10/2007
KR	100905390	3/2008
KR	1020080019311	3/2008
TW	I260101	8/2006
TW	M332265	5/2008
TW	M341313	9/2008

TW	M363159	8/2009
WO	WO 2011/092486	8/2011

OTHER PUBLICATIONS

Ahn et al., Machine translation of KR 2008-019311 A, Mar. 2008.*
 Chinese Evaluation Report, Chinese Patent Application No.
 ZL2011202494065, 7 pages, Jul. 26, 2013.
 Taiwanese Office action with English translation, Taiwanese Appli-
 cation No. 100124794, 15 pages, Dec. 4, 2013.

* cited by examiner

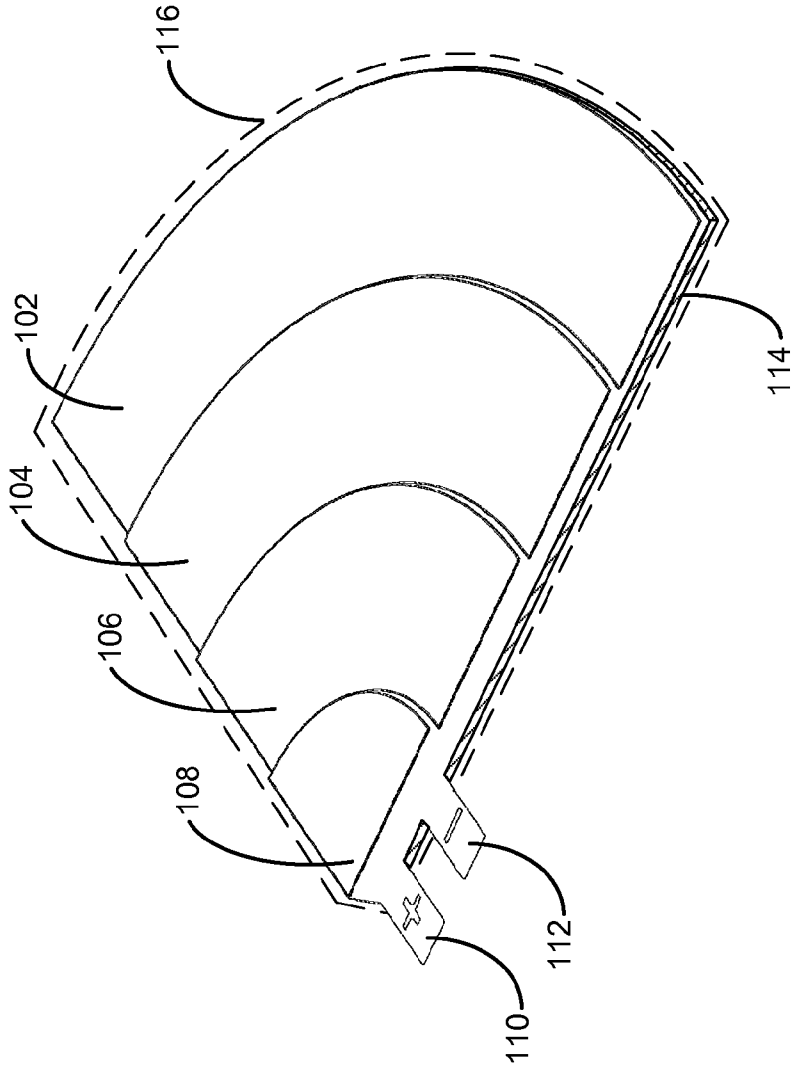


FIG. 1

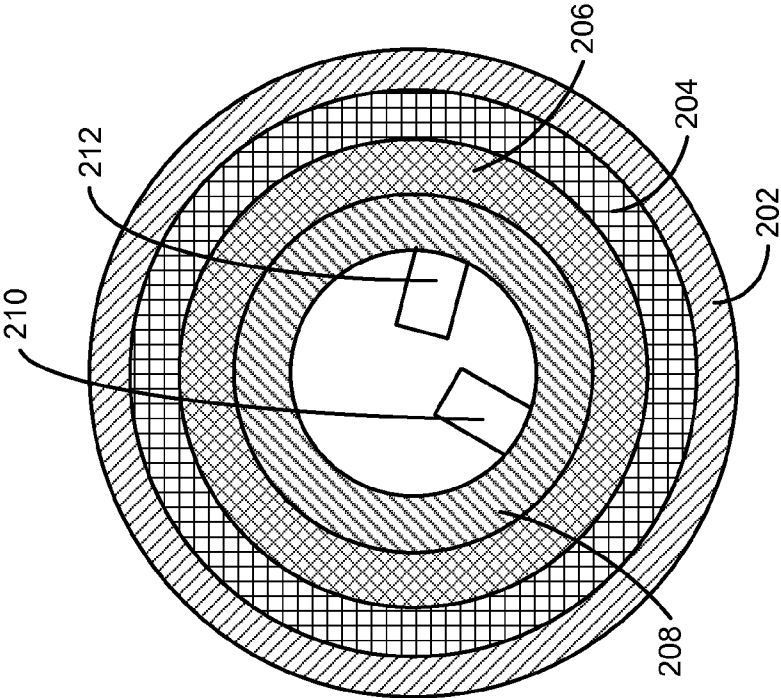


FIG. 2

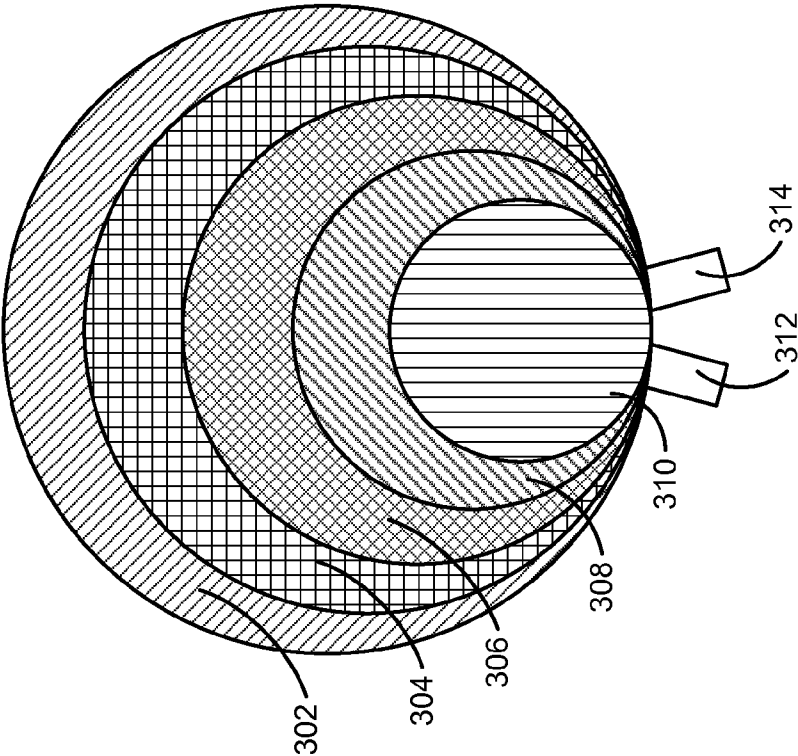


FIG. 3

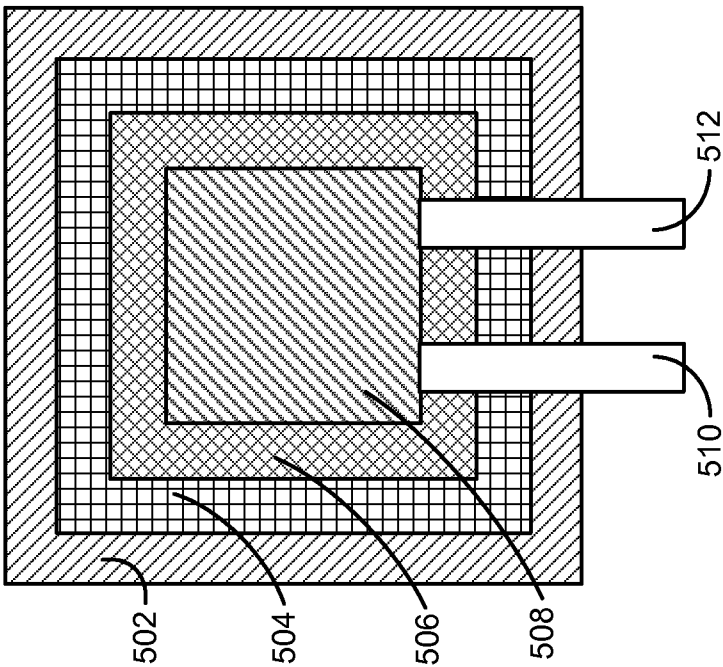


FIG. 5

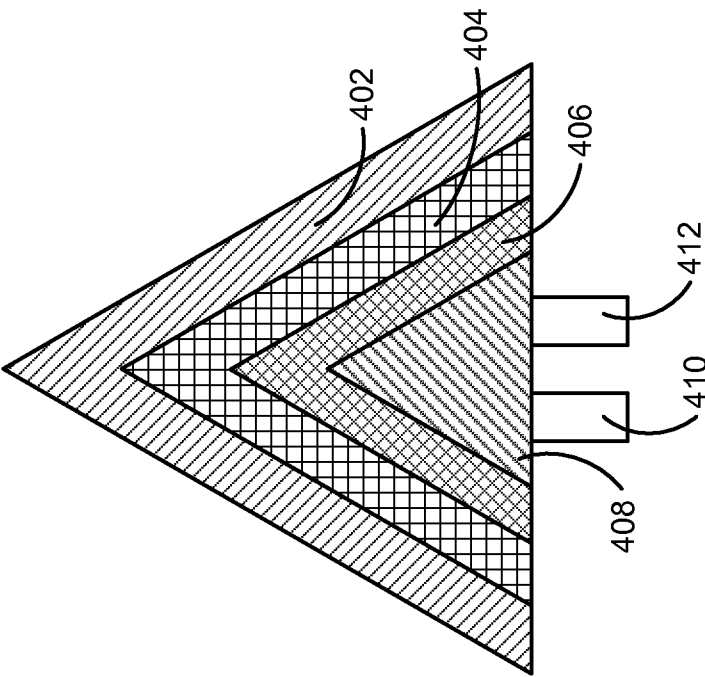


FIG. 4

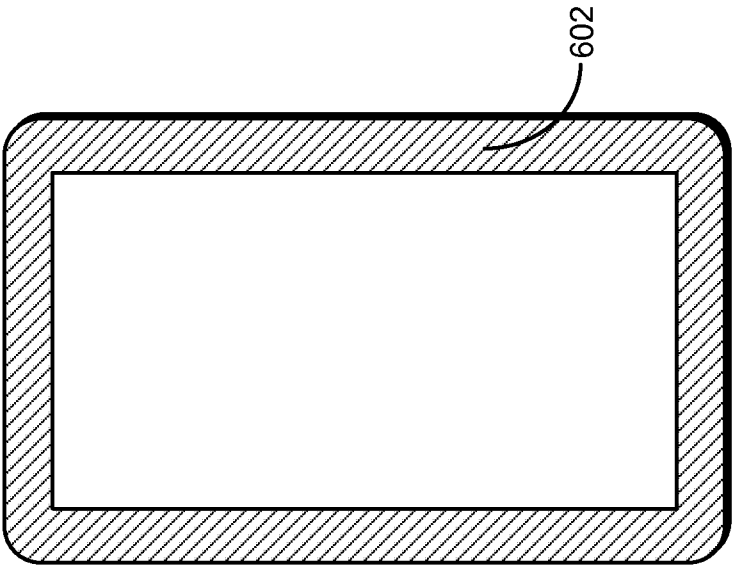


FIG. 6

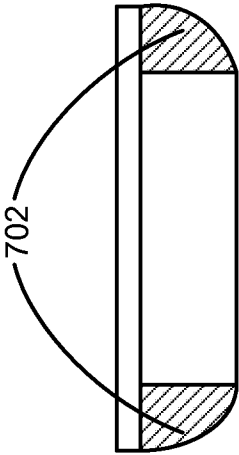
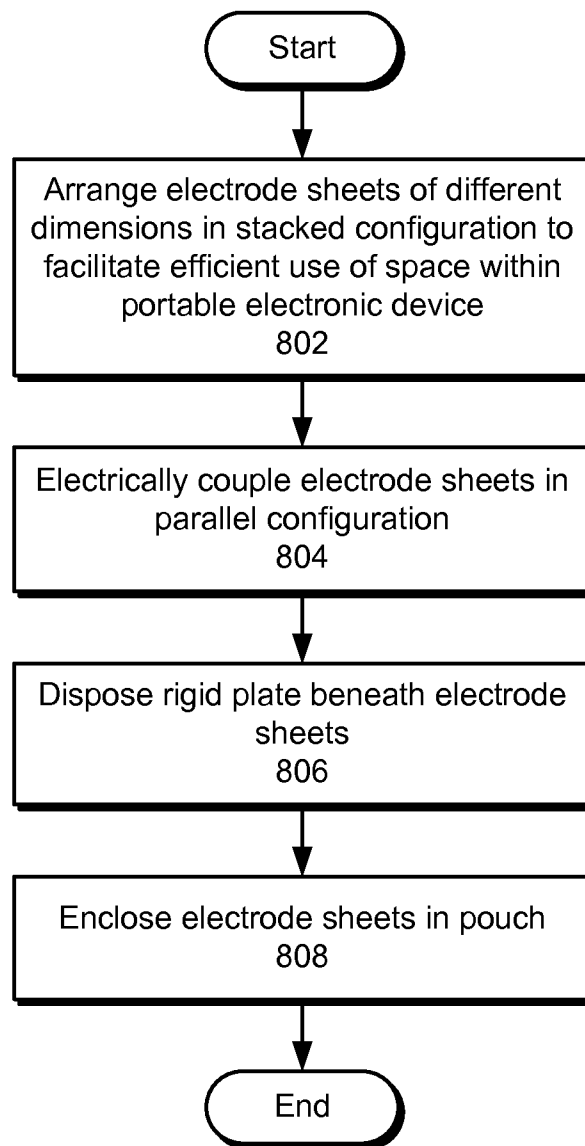
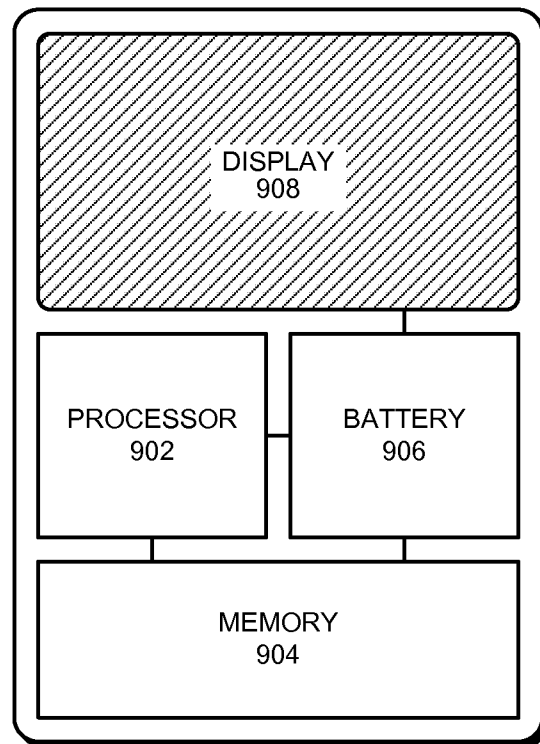


FIG. 7

**FIG. 8**



PORTABLE ELECTRONIC DEVICE 900

FIG. 9

1

CONSTRUCTION OF NON-RECTANGULAR BATTERIES

BACKGROUND

1. Field

The present embodiments relate to batteries for portable electronic devices. More specifically, the present embodiments relate to the design and constructions of non-rectangular battery cells to facilitate efficient use of space within portable electronic devices.

2. Related Art

Rechargeable batteries are presently used to provide power to a wide variety of portable electronic devices, including laptop computers, mobile phones, PDAs, digital music players and cordless power tools. The most commonly used type of rechargeable battery is a lithium battery, which can include a lithium-ion or a lithium-polymer battery.

Lithium-polymer batteries often include cells that are packaged in flexible pouches. Such pouches are typically lightweight and inexpensive to manufacture. Moreover, pouches may be tailored to various cell dimensions, allowing lithium-polymer batteries to be used in space-constrained portable electronic devices such as mobile phones, laptop computers, and/or digital cameras. For example, a lithium-polymer battery cell may achieve a packaging efficiency of 90-95% by enclosing rolled electrodes and electrolyte in an aluminized laminated pouch. Multiple pouches may then be placed side-by-side within a portable electronic device and electrically coupled in series and/or in parallel to form a battery for the portable electronic device.

However, efficient use of space may be limited by the use and arrangement of cells in existing battery pack architectures. In particular, battery packs typically contain rectangular cells of the same capacity, size, and dimensions. The physical arrangement of the cells may additionally mirror the electrical configuration of the cells. For example, a six-cell battery pack may include six lithium-polymer cells of the same size and capacity configured in a two in series, three in parallel (2s3p) configuration. Within the battery pack, two rows of three cells placed side-by-side may be stacked on top of each other; each row may be electrically coupled in a parallel configuration and the two rows electrically coupled in a series configuration. Consequently, the battery pack may require space in a portable electronic device that is at least the length of each cell, twice the thickness of each cell, and three times the width of each cell. Furthermore, the battery pack may be unable to utilize free space in the portable electronic device that is outside of a rectangular space reserved for the battery pack.

Hence, the use of portable electronic devices may be facilitated by improvements related to the packaging efficiency, capacity, form factor, cost, design, and/or manufacturing of battery packs containing lithium-polymer battery cells.

SUMMARY

The disclosed embodiments relate to a battery cell which includes a set of electrode sheets of different dimensions arranged in a stacked configuration to facilitate efficient use of space inside a portable electronic device. For example, the electrode sheets may be arranged in the stacked configuration to accommodate a shape of the portable electronic device. The stacked configuration may be based on a non-rectangular battery design such as a toroidal design, an L-shaped design, a triangular design, a pie-shaped design, a cone-shaped design, and/or a pyramidal design.

2

The electrode sheets may be electrically coupled in a parallel configuration. The parallel configuration may involve electrically coupling a first set of conductive tabs, wherein each of the first set of conductive tabs is coupled to a cathode of one of the electrode sheets, and electrically coupling a second set of conductive tabs, wherein each of the second set of conductive tabs is coupled to an anode of one of the electrode sheets.

In some embodiments, the first set of conductive tabs is electrically coupled using at least one of a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and an ultrasonic-welding technique. The second set of conductive tabs may also be electrically coupled using the same technique(s).

In some embodiments, the battery cell also includes a pouch enclosing the electrode sheets.

In some embodiments, the battery cell also includes a rigid plate disposed beneath the electrode sheets inside the pouch.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 shows a battery cell in accordance with an embodiment.

FIG. 2 shows a non-rectangular design for a battery cell in accordance with an embodiment.

FIG. 3 shows a non-rectangular design for a battery cell in accordance with an embodiment.

FIG. 4 shows a non-rectangular design for a battery cell in accordance with an embodiment.

FIG. 5 shows a non-rectangular design for a battery cell in accordance with an embodiment.

FIG. 6 shows the placement of a battery within a portable electronic device in accordance with an embodiment.

FIG. 7 shows the placement of a battery within a portable electronic device in accordance with an embodiment.

FIG. 8 shows a flowchart illustrating the process of manufacturing a battery cell in accordance with an embodiment.

FIG. 9 shows a portable electronic device in accordance with an embodiment.

In the figures, like reference numerals refer to the same figure elements.

DETAILED DESCRIPTION

The following description is presented to enable any person skilled in the art to make and use the embodiments, and is provided in the context of a particular application and its requirements. Various modifications to the disclosed embodiments will be readily apparent to those skilled in the art, and the general principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the present disclosure. Thus, the present invention is not limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

The data structures and code described in this detailed description are typically stored on a computer-readable storage medium, which may be any device or medium that can store code and/or data for use by a computer system. The computer-readable storage medium includes, but is not limited to, volatile memory, non-volatile memory, magnetic and optical storage devices such as disk drives, magnetic tape, CDs (compact discs), DVDs (digital versatile discs or digital video discs), or other media capable of storing code and/or data now known or later developed.

The methods and processes described in the detailed description section can be embodied as code and/or data,

which can be stored in a computer-readable storage medium as described above. When a computer system reads and executes the code and/or data stored on the computer-readable storage medium, the computer system performs the methods and processes embodied as data structures and code and stored within the computer-readable storage medium.

Furthermore, methods and processes described herein can be included in hardware modules or apparatus. These modules or apparatus may include, but are not limited to, an application-specific integrated circuit (ASIC) chip, a field-programmable gate array (FPGA), a dedicated or shared processor that executes a particular software module or a piece of code at a particular time, and/or other programmable-logic devices now known or later developed. When the hardware modules or apparatus are activated, they perform the methods and processes included within them.

The disclosed embodiments provide a battery cell with a non-rectangular design. The battery cell may include a set of electrode sheets of different dimensions arranged in a stacked configuration. The non-rectangular shape of the stacked configuration may facilitate efficient use of space in a portable electronic device. The term "non-rectangular" can mean that the cells are not rectangular through any cutting plane, which means that the cells are not rectangular when viewed from the top, bottom, or sides. For example, the non-rectangular stacked configuration may be based on a toroidal design, an L-shaped design, a triangular design, a pie-shaped design, a cone-shaped design, and/or a pyramidal design. The electrode sheets may also be enclosed in a pouch to form a lithium-polymer battery cell. Moreover, a rigid plate may be disposed beneath the electrode sheets inside the pouch to provide structural support for the battery cell.

The electrode sheets may then be electrically coupled in a parallel configuration. In particular, the cathode of each electrode sheet may be electrically coupled to one of a first set of conductive tabs, and the anode of each electrode sheet may be electrically coupled to one of a second set of conductive tabs. The first set of conductive tabs may then be electrically coupled using a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and/or an ultrasonic-welding technique. The same technique(s) may also be used to electrically couple the second set of conductive tabs. The first and second sets of conductive tabs may extend through seals in the pouch to provide terminals for the battery cell.

FIG. 1 shows a battery cell in accordance with an embodiment. The battery cell may supply power to a portable electronic device such as a laptop computer, mobile phone, tablet computer, personal digital assistant (PDA), portable media player, digital camera, and/or other type of battery-powered electronic device.

As shown in FIG. 1, the battery cell includes a number of layers **102-108** that form a wedge-shaped, terraced structure. Layers **102-108** may be formed from thin electrode sheets; each electrode sheet may provide a cathode for the battery cell on one side and an anode for the battery cell on the other side. For example, each electrode sheet may have a thickness of around 20 microns. The electrode sheet may also include an anode of lithium or zinc and a cathode of manganese dioxide.

Moreover, the electrode sheets may be arranged in a stacked configuration to form layers **102-108**. In particular, the terraced, curved structure of the battery cell may be created using flat pie-shaped electrode sheets of four different sizes. First, a series of electrode sheets of the largest size may be stacked to form layer **102**, then a series of smaller pie-shaped electrode sheets may be stacked on top of layer **102** to form layer **104**. After layers **102-104** are formed, a number of

the third-largest electrode sheets may be stacked on top of layer **104** to form layer **106**, and finally, the smallest electrode sheets are placed on top of layer **106** to form layer **108**.

To form a power source, the electrode sheets may be electrically coupled in a parallel configuration and enclosed in a pouch **116**. To electrically couple the electrode sheets, each cathode from the electrode sheets may be electrically coupled to one of a first set of conductive tabs, and each anode from the electrode sheets may be electrically coupled to one of a second set of conductive tabs. The first set of conductive tabs may then be electrically coupled using a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and/or an ultrasonic-welding technique to form a positive terminal **110** for the battery cell.

The same technique(s) may also be used to electrically couple the second set of conductive tabs to form a negative terminal **112** for the battery cell. For example, the battery cell may be assembled by stacking electrode sheets coupled to conductive tabs against one or more surfaces that align the corners of the electrode sheets and the conductive tabs. The conductive tabs may then be spot-welded together to form terminals **110-112**.

To enclose the battery cell in pouch **116**, layers **102-108** may be placed on top of a sheet of polymer laminate and/or another type of flexible pouch material. Another sheet of pouch material may then be placed over the tops of layers **102-108**, and the two sheets may be heat-sealed and/or folded. Alternatively, layers **102-108** may be placed in between two sheets of pouch material that are sealed and/or folded on some (e.g., non-terminal) sides. The remaining side(s) may then be heat-sealed and/or folded to enclose layers **102-108** within pouch **116**. Terminals **110-112** may extend through seals in pouch **116** to allow the battery cell to be electrically coupled to other components in the portable electronic device.

Those skilled in the art will appreciate that the thin and/or flexible nature of the electrode sheets may cause the electrode sheets to bend and/or deform within the battery cell during handling and/or installation within the portable electronic device. As a result, a rigid plate **114** may be disposed beneath layers **102-108** to provide structural support for the battery cell.

In one or more embodiments, the battery cell of FIG. 1 facilitates efficient use of space within the portable electronic device. For example, the terraced and/or curved edges of the battery cell may allow the battery cell to fit within a curved enclosure for the portable electronic device. The number of layers (e.g., layers **102-108**) may also be increased or decreased to better fit the curvature of the portable electronic device's enclosure. In other words, the battery cell may include an asymmetric and/or non-rectangular design that accommodates the shape of the portable electronic device. In turn, the battery cell may provide greater capacity, packaging efficiency, and/or voltage than rectangular battery cells in the same portable electronic device. Non-rectangular designs for battery cells are discussed in further detail below with respect to FIGS. 2-5.

FIG. 2 shows a non-rectangular design for a battery cell in accordance with an embodiment. More specifically, FIG. 2 shows a top-down view of a battery cell with a number of layers **202, 204, 206** and **208**. Layers **202-208** may be formed by arranging electrode sheets of different dimensions in a stacked configuration that is based on a toroidal and/or cone-shaped design for the battery cell. Consequently, the electrode sheets used in the battery cell of FIG. 2 may be round and/or ellipsoidal.

5

Moreover, the electrode sheets forming layers **202-208** may be hollow to enable the formation of two terminals **210-212**. Each terminal **210-212** may include a set of conductive tabs that connects the cathodes or the anodes of the electrode sheets. For example, terminal **210** may correspond to a positive terminal for the battery cell and include a first set of conductive tabs electrically coupled to one another and to the cathodes of the electrode sheets. Terminal **212** may correspond to a negative terminal for the battery cell and include a second set of conductive tabs electrically coupled to one another and to the anodes of the electrode sheets.

The battery cell of FIG. 2 may be designed to fit around the perimeter of a portable electronic device. For example, layers **202-208** may accommodate a curved and/or scalloped outline of the portable electronic device, while the hollow interior of the battery cell may allow components (e.g., printed circuit boards (PCBs), processors, memory, storage, display, optical drives, etc.) to be placed in the middle of the portable electronic device. Placement of battery cells within portable electronic devices is discussed in further detail below with respect to FIGS. 6-7.

FIG. 3 shows a non-rectangular design for a battery cell in accordance with an embodiment. As with the battery cell of FIG. 2, the battery cell of FIG. 3 includes a number of layers **302, 304, 306, 308** and **310** formed by stacking round and/or ellipsoidal electrode sheets of the same thickness (e.g., 10-20 microns) and varying sizes. However, because layers **302-310** are not hollow, terminals **312-314** for the battery cell may be placed outside layers **302-310**. The skewed-cone shape of the battery cell may allow the battery cell to fit within a recessed pocket in a portable electronic device.

FIG. 4 shows a non-rectangular design for a battery cell in accordance with an embodiment. The battery cell of FIG. 4 may be formed from four layers **402-408** of triangular electrode sheets that are aligned along one edge and stacked. Each layer individual layer **402, 404, 406** and **408** may include electrode sheets of the same size, while the different layers **402, 404, 406** and **408** may be formed from electrode sheets of four different sizes. The battery cell may thus be based on a pyramidal and/or triangular design. Furthermore, a set of terminals **410-412** may electrically couple the electrode sheets in a parallel configuration and allow the battery cell to supply power to a portable electronic device.

FIG. 5 shows a non-rectangular design for a battery cell in accordance with an embodiment. The battery cell of FIG. 5 may include four layers **502, 504, 506** and **508** of square electrode sheets arranged in a stacked configuration. However, unlike the battery cells of FIGS. 1-4, the electrode sheets of FIG. 5 may be centered on top of each other. As a result, terminals **510-512** for the battery cell may be formed from conductive tabs that overlap with surfaces of electrode sheets to which the conductive tabs should not be electrically coupled. For example, conductive tabs that are electrically coupled to electrode sheets of layer **504** may overlap with the topmost electrode sheet of layer **502**.

To prevent electric current from flowing between overlapping electrode sheets and conductive tabs, a conductive tab may be insulated from an overlapping surface of an electrode sheet to which the conductive tab should not be electrically coupled by placing a layer of insulating material such as Kapton (Kapton™ is a registered trademark of E. I. du Pont de Nemours and Company Corporation) in between the conductive tab and the electrode sheet. Such use of insulating materials in the battery cell may enable the creation of battery cells of arbitrary three-dimensional (3D) shapes, which in turn may further facilitate the efficient use of space inside portable electronic devices that use the battery cells.

6

FIG. 6 shows the placement of a battery **602** within a portable electronic device in accordance with an embodiment. As shown in FIG. 6, a top-down view of battery **602** shows that battery **602** is placed along the outside perimeter of the portable electronic device. Furthermore, the battery may include a toroidal, L-shaped, and/or pie-shaped design to accommodate a curved and/or scalloped shape of the portable electronic device. The interior of the battery may be hollow to allow components to be placed within the portable electronic device.

FIG. 7 shows the placement of a battery **702** within a portable electronic device in accordance with an embodiment. Battery **702** may be based on the same design as battery **602** of FIG. 6. More specifically, a cross-sectional view of battery **702** shows that battery **702** fills up the space along the curved sides of the portable electronic device. As a result, battery **702** may represent increased packaging efficiency and/or capacity over a rectangular battery that is used in the same portable electronic device.

FIG. 8 shows a flowchart illustrating the process of manufacturing a battery cell in accordance with an embodiment. In one or more embodiments, one or more of the steps may be omitted, repeated, and/or performed in a different order. Accordingly, the specific arrangement of steps shown in FIG. 8 should not be construed as limiting the scope of the embodiments.

First, a set of electrode sheets of different dimensions is arranged in a stacked configuration to facilitate efficient use of space within a portable electronic device (operation **802**). For example, electrode sheets of the same thickness and varying lengths and/or widths may be stacked to form a battery cell that is based on a non-rectangular (e.g., toroidal, L-shaped, triangular, pie-shaped, cone-shaped, pyramidal) battery design.

Next, the electrode sheets are electrically coupled in a parallel configuration (operation **804**). Each cathode from the electrode sheets may be electrically coupled to one of a first set of conductive tabs, and each anode from the electrode sheets may be electrically coupled to one of a second set of conductive tabs. The first set of conductive tabs may then be electrically coupled using a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and/or an ultrasonic-welding technique to form a positive terminal for the battery cell. The same technique(s) may also be used to electrically couple the second set of conductive tabs to form a negative terminal for the battery cell. In addition, a conductive tab may be insulated from an overlapping surface of an electrode sheet to which the conductive tab should not be electrically coupled by placing a layer of insulating material such as Kapton in between the conductive tab and the electrode sheet.

A rigid plate may also be disposed beneath the electrode sheets (operation **806**) to provide structural support for the battery cell. Such structural support may prevent the battery cell from flexing and/or distorting during handling and/or installation within a portable electronic device. Finally, the electrode sheets and rigid plate may be enclosed in a pouch (operation **808**). Consequently, the battery cell may correspond to a lithium-polymer battery cell that is designed to accommodate the shape of the portable electronic device. For example, the battery cell may be placed within a curved interior of the portable electronic device to provide increased capacity and/or packaging efficiency over battery packs containing rectangular cells.

The above-described rechargeable battery cell can generally be used in any type of electronic device. For example, FIG. 9 illustrates a portable electronic device **900** which

7

includes a processor **902**, a memory **904** and a display **908**, which are all powered by a battery **906**. Portable electronic device **900** may correspond to a laptop computer, mobile phone, PDA, portable media player, digital camera, and/or other type of battery-powered electronic device. Battery **906** may correspond to a battery pack that includes one or more battery cells. Each battery cell may include a set of electrode sheets of different dimensions arranged in a stacked configuration. The stacked configuration may facilitate efficient use of space inside portable electronic device **900**. For example, the stacked configuration may allow battery **906** to fit along the perimeter of a mobile phone with a scalloped shape.

The foregoing descriptions of various embodiments have been presented only for purposes of illustration and description. They are not intended to be exhaustive or to limit the present invention to the forms disclosed. Accordingly, many modifications and variations will be apparent to practitioners skilled in the art. Additionally, the above disclosure is not intended to limit the present invention.

What is claimed is:

1. A battery cell, comprising:
 - a set of electrode sheets of different dimensions, wherein the electrode sheets are electrically coupled in parallel and arranged in a stacked configuration;
 - a pouch enclosing the electrode sheets; and
 - a rigid plate beneath the stacked configuration of electrode sheets and within the pouch, wherein the rigid plate provides structural support for the stacked configuration of electrode sheets and wherein the set of electrode sheets has a hollow interior portion.
2. The battery cell of claim 1, wherein electrically coupling the electrode sheets in parallel comprises:
 - electrically coupling a first set of conductive tabs, wherein each of the first set of conductive tabs is coupled to a cathode of one of the electrode sheets; and
 - electrically coupling a second set of conductive tabs, wherein each of the second set of conductive tabs is coupled to an anode of one of the electrode sheets.
3. The battery cell of claim 2, wherein the first set of conductive tabs is electrically coupled using at least one of a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and an ultrasonic-welding technique.
4. The battery cell of claim 1, wherein the electrode sheets are arranged in the stacked configuration based on a non-rectangular battery design.
5. The battery cell of claim 4, wherein the non-rectangular battery design is at least one of a toroidal design, a triangular design, a pie-shaped design, a cone-shaped design, and a pyramidal design.
6. The battery cell of claim 1, wherein at the hollow interior portion of the set of electrode sheets is configured to house components of an electronic device.
7. A method for providing a power source for a portable electronic device, comprising:
 - arranging a set of electrode sheets of different dimensions in a stacked configuration, wherein the set of electrode sheets has a hollow interior portion;
 - disposing a rigid plate beneath the stacked configuration of electrode sheets, wherein the rigid plate provides structural support for the stacked configuration of electrode sheets;
 - enclosing the electrode sheets and the rigid plate in a pouch; and
 - electrically coupling the electrode sheets in a parallel configuration.

8

8. The method of claim 7, wherein electrically coupling the electrode sheets in the parallel configuration involves:

- electrically coupling a first set of conductive tabs, wherein each of the first set of conductive tabs is coupled to a cathode of one of the electrode sheets; and
- electrically coupling a second set of conductive tabs, wherein each of the second set of conductive tabs is coupled to an anode of one of the electrode sheets.

9. The method of claim 8, wherein the first set of conductive tabs is electrically coupled using at least one of a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and an ultrasonic-welding technique.

10. The method of claim 7, wherein the electrode sheets are arranged in the stacked configuration based on at least one of a toroidal design, a triangular design, a pie-shaped design, a cone-shaped design, and a pyramidal design.

11. A battery pack, comprising:

- a set of electrode sheets of different dimensions electrically coupled in parallel and arranged in a stacked configuration, wherein the set of electrode sheets has a hollow interior portion;
- a rigid plate disposed beneath the stacked configuration of electrode sheets; and
- a pouch enclosing the stacked configuration of electrode sheets and the rigid plate.

12. The battery pack of claim 11, wherein electrically coupling the electrode sheets in parallel comprises:

- electrically coupling a first set of conductive tabs, wherein each of the first set of conductive tabs is coupled to a cathode of one of the electrode sheets; and
- electrically coupling a second set of conductive tabs, wherein each of the second set of conductive tabs is coupled to an anode of one of the electrode sheets.

13. The battery pack of claim 12, wherein the first set of conductive tabs is electrically coupled using at least one of a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and an ultrasonic-welding technique.

14. The battery pack of claim 11, wherein the electrode sheets are arranged in the stacked configuration based on at least one of a toroidal design, a triangular design, a pie-shaped design, a cone-shaped design, and a pyramidal design.

15. The battery pack of claim 11, wherein the electrode sheets are arranged in the stacked configuration to accommodate a shape of the portable electronic device.

16. A portable electronic device, comprising:

- a set of components powered by a battery pack, the battery pack comprising:
 - a set of electrode sheets of different dimensions electrically coupled in parallel and arranged in a stacked configuration, wherein the set of electrode sheets has a hollow interior portion configured to receive at least one component of the set of components powered by the battery pack;
 - a rigid plate disposed beneath the stacked configuration of electrode sheets; and
 - a pouch enclosing the stacked configuration of electrode sheets and the rigid plate.

17. The portable electronic device of claim 16, wherein electrically coupling the electrode sheets in parallel comprises:

- electrically coupling a first set of conductive tabs, wherein each of the first set of conductive tabs is coupled to a cathode of one of the electrode sheets; and

electrically coupling a second set of conductive tabs, wherein each of the second set of conductive tabs is coupled to an anode of one of the electrode sheets.

18. The portable electronic device of claim **17**, wherein the first set of conductive tabs is electrically coupled using at least one of a wire-bonding technique, a spot-welding technique, a crimping technique, a riveting technique, and an ultrasonic-welding technique. 5

19. The portable electronic device of claim **16**, wherein the electrode sheets are arranged in the stacked configuration based on at least one of a toroidal design, a triangular design, a pie-shaped design, a cone-shaped design, and a pyramidal design. 10

20. The portable electronic device of claim **19**, wherein the electrode sheets are arranged in the stacked configuration to accommodate a shape of the portable electronic device. 15

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,940,429 B2
APPLICATION NO. : 12/837932
DATED : January 27, 2015
INVENTOR(S) : Bradley L. Spare

Page 1 of 1

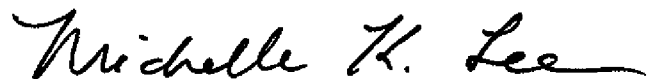
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Claim 6, beginning at Column 7, line 52 should read:

6. The battery cell of claim 1, wherein [[at]] the hollow interior portion of the set of electrode sheets is configured to house components of an electronic device.

Signed and Sealed this
Twenty-eighth Day of April, 2015

A handwritten signature in black ink, reading "Michelle K. Lee". The signature is written in a cursive style with a long, sweeping underline.

Michelle K. Lee
Director of the United States Patent and Trademark Office